A Study on Dynamics of Agroecology of Biodiversity Park (Anupam Upavan) Established by DEI

Synopsis

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INTRODUCTION

The Earth's human population reached 7.7 billion in 2019. Only in the last 13 years have one billion people added to it. Today, Earth's population is using more of its resources than it can provide. The global population is expected to reach 8.5 billion in 2030, 9.7 billion in 2050 (UN 2019). With the increasing population use of resources is expected to double by 2050 (UNEP 2017). Increasing population demands natural resource and industrial development leads to air pollution, surface and groundwater contamination, soil degradation, global warming, climate change and other environmental pollution (Nagdeve et al. 2007). Minerals and Energy resources are in abundance in forest areas, demand of natural resources has significantly increased and mining in forest areas is a major cause of forest destruction and biodiversity loss (WRI. 2014). Forest restoration increases land productivity and enhances biodiversity richness in an ecosystem (Grant et al. 2007). Restoring forest in barren land requires huge amounts of natural resources. Freshwater availability is a growing concern with a growing population (Hoekstra et al. 2012). Availability of freshwater in the form of municipal waste has been used to irrigate these growing forests and parks. Municipal waste water comprises 99.9% of water and organic and inorganic materials. It is a good source of nitrogen, phosphorus and potassium (FAO). But it can be a source of introducing toxic elements (Bennicelli et al. 2004) in soil. Recycling and reuse of Sewage treated water is important for agriculture purposes and high efficiency of water use (Emongor 2004).

Globally, nearly 33% of the land is acquired by forest and contains more than 80% of the terrestrial biodiversity (Aerts et al. 2011). Deforestation led to a decrease in population size of the plants and animals (Laurence et al. 2008) and it may lead to population viability (Honnay et al. 2005) and genetic variation (Auguilar et al. 2008). Establishing biodiversity parks can help in improving variation in floral and faunal diversity.

Food demand will increase by 70% to feed the growing population in 2050 (FAO 2009). This means the use of more synthetic chemical pesticides, fertilisers but using chemical pesticides and fertilisers adversely affected the land ecosystem and biodiversity. Emitted ammonia from agricultural land can bind with pollution from vehicle exhaust creating dangerous particulates and causing respiratory disease

including COVID 19. Studies revealed that air pollution increased mortality with COVID 19 by 15 percent (UNEP 2020). Atmospheric nitrous oxide is significantly increased due to the use of synthetic fertilisers, 2 percent of manure nitrogen and 2.5 percent of fertiliser nitrogen have been converted into nitrous oxide from 1860 to 2005 (Davidson et al. 2009). Nitrous oxide has far more potential for global warming due to its far heavier weight than carbon dioxide and methane. By considering associated problems with synthetic pesticides and fertilisers it seems that it is not going to be a viable solution for the agroecosystem and the environment.

The intensification and expansion of chemical-driven agriculture dramatically declined the population of species that benefited the Agroecosystem (Hole et al. 2005). Organic farming is considered a sustainable method of farming and the sector is growing rapidly in many countries (Rigby 2008 et al.). Organic farming is a low-yielding agriculture system that is eco-friendly, maintains soil fertility, avoids pollution, and improves the overall ecosystem. Organic farming is distinguished from another farming method by the only two principles: prohibition of soluble minerals and rejection of synthetic pesticides, resulting in costly products, low yield, and inefficient use of land. Although supporters of Organic farming assert it is a superior agricultural method among all farming methods but due to lack of scientific study this claim can not be substantiated (Trewavas 2001).

Agrochemical subsidy leads to extremely serious agricultural pollution (Chen et al. 2017). Climate change is mainly caused by greenhouse gases and it is found that agrochemicals are one of the sources of greenhouse gases (Fynn et al. 2010). Chemical pesticides and fertilizers pose severe hazards to nature and contaminate natural resources like soil and water, ultimately it leads to contamination of crops and causing ill-effects to the ecosystem (Khanna et al. 2018). These agrochemicals affect not only nature but also affect the human endocrine and immune systems and may promote the development of cancer. In March 2017 the United Nations published a report, the report says chronically affected people from pesticides lead to the development of Alzheimer's and Parkinson's diseases, hormone disruption, developmental disorders, and sterility. And causes approximately 2,00,000 deaths (UN 2017). To cope with these problems, organic farming is an alternate solution that ensures an increased amount of organic

carbon in soil, good soil structure and biological activity, nutrient supply to the plant, and positively affects the health and productivity of crops and livestock (Watson et al. 2006).

Forecasting population growth, increased pollution, climate change, global warming, and deteriorated soil quality, and deteriorated food quality is significantly increased while natural resources like minerals, forests, fertile land, and water are depleting rapidly. Therefore, conservation of natural resources is a challenge with increased agricultural productivity and maintaining biodiversity richness. Conservation of Nutrients, water, genetic diversity, population size of plants and animals and related ecological resources is a pathway to live a safe and sustainable life on Earth.

The Biodiversity park (Anupam Upavan) was once deserted land, but it was transformed 7 years ago into green land called Biodiversity Park III, after agro-ecological activities began on 8 acres of land. Four years ago, agro ecological activity was started in 6 acre land in the eastern side of Biodiversity park III. About two years ago Anupam Upavan was started with approximately 25 acres of land. Still, some part of the anupam upavan, known as "Chandmari Ka Teela", remained untouched and deserted. It contained approximately 40-50 species of plants and animals. This study is focused on holistic study of development and improvement of the ecosystem through agro ecological practices.

OBJECTIVES

In view of the effects of various agro-ecological practices and dynamics of ecological factors biodiversity parks the present study will be undertaken with the following objectives:

1. To study the physico-chemical parameters and dynamics of soil
2. To study the physico-chemical parameters of water and their effects on soil
3. To study the air quality of biodiversity park and nearby colonies
4. To estimate and study the floral and faunal diversity
5. To study the dynamics of microbial population in soil.

REVIEW OF LITERATURE

Agroforestry is the integrated production of crops, woody plant and livestock nurturing which is important for ecological balance while generating profits from it (Mosquera-Losada 2009). Components of an agroecosystem are pollinators, predators, parasites, weeds, earthworms, soil microflora and

herbivores (Altieri 2009). A detailed study depicted by Howard's (1940) the reasons behind the deterioration and erosion of soil in Howard's Agricultural Testament and suggested methods to restore and maintain soil fertility. Conventional agricultural practises such as intensive tilling and use of agrochemicals are reducing the population of soil fauna and flora, imbalancing soil pH, Ion concentration and affecting soil structure (Arden-Clarke et al. 1988), on the other hand organic farming practises improve soil fertility, water retention power, increase microbial diversity, even distribution of macronutrients and micronutrients and facilitate root growth (Rowen et al. 2019).

Organic Farming is defined as an approach to growing crops and raising livestock that avoids synthetic chemicals, hormones, antibiotic agents, genetic engineering, and irradiation (Forman et al. 2012). Intensive farming is considered un-sustainable and inadequate to address great global challenges such as climate change, environmental pollution, food security and declining biodiversity. Agroforestry is an agroecological approach completely based on diversification of the agroecosystem and maintaining and intensifying the agroecological relationship. The integration of agroforestry and organic farming practices can be a pathway for sustainable production of agricultural produce along with the fluorising ecosystem (Wezel et al. 2020).

Developing such agroecological parks requires a huge amount of resources and availability of water to irrigate them as one of the main challenges. Agra district is already facing challenges of groundwater scarcity (Rao et al. 2009). A Spatio-temporal analysis of groundwater levels of Agra city studied by Biswas and Rawat (Biswas et al. 2018) found that pre- and post-monsoon under groundwater levels would decline to 27.78 M (below ground level) and 26.84 M (bgl) respectively by 2020. Under these conditions, using groundwater to develop agroforest is not a viable solution. Hence sewage water has been used to irrigate these developing parks. But the problem associated with Sewage water is contamination of heavy metals (Pb, B, Cd, Zn, Cr, Cu, Cd and Mn etc) (Maurya et al. 2019) which ultimately would deposit and can affect the dynamics of agroecology. Microwave plasma atomic emission spectroscopy (MP-AES) is a very cost-effective and newly emerged analytical technique which gives precise and accurate data of trace elements in different types of soil, air particulate matter, sewage water and sewage sediments (Kamla et al. 2014). MP-AES can quantify efficiently major heavy metals

like Ca, K, Mg, Na, Al, Fe, and Mg or trace metals like As, Ba, Cd, Co, Cr, Cu, Mo, Ni, Pb, V, Zn (Karlsson et al. 2015). Nitrogen pollution in groundwater is a global concern in areas with intensive agriculture (Denk et al. 2017) and Nitrogen compounds such as NO_3^-, NH_4^+, NO_2^- are detrimental to human health (Townsend et al. 2003).

Use of agrochemicals in intensive agriculture has already devastating effects on environment and biodiversity loss (Roe et al. 2019). Due to the heavy use of pesticides, in European countries bird populations are facing an approximate reduction of 30%. Altogether, 1,211 bird species are threatened due to chemical pollution, including fertilisers and pesticides (BLI 2004). Woodcock et al. (2016) found that there is a strong correlation between pesticide use and decline in bee population and lead to a reduction in agricultural yields (Stanley et al. 2016), Increasing population demands rapid and sustainable food production, according to Searchinger et al. (2018) the food demand will increase 50% by 2050. Agroecology is a transdisciplinary area that has a scientific and philosophical approach for promoting sustainable agriculture with ecological and socioeconomic value (Caporali 2010).

Organic approach of development of agroforestry has a positive impact on diversity. A diverse and species enriched ecosystem is more productive than one which has lost species (Chapin et al. 2002). A report published in the International Federation of Organic Agriculture Movements in February 2020 stated that organic food surpassed 100 billion US dollars for the first time in 2018. The total organic producer around the globe is 2.8 million and India continues to be in the lead with 1.14 million organic producers. There has been a steady increase in organic farmland by 2.9 % (2 million hectares) between 2017 to 2018 (IFOAM 2020). The number of insects and their population are usually higher in number (Bengtsson et al 2005). Moths were considerably more abundant in organic farms (Wickramasinghe et al 2004).

Woodruff et al. (2008) demonstrated that production, release, transport, metabolism, and elimination of hormones that regulate homeostasis and other developmental processes are impacted by many agricultural pesticides (Peiris-John et al. 2008). Organic farming has less environmental impact than conventional farming (Forman et al. 2012). Organically grown food products are healthier and safer than

inorganic food products (Dardak et al. 2009). Health awareness on safe food consumption and eco-friendly perception of people led to the selection of organic products (Maya et al. 2011).

Conversion of forest into agricultural land causes huge loss of soil organic carbon stock into the atmosphere, about 20 to 70% of stored carbon released by cultivation land in just two decades. Carbon dioxide, methane and nitrous oxide are the main cause of increase in global climate change, deforestation and burning of fossil fuels is one of the main causes of increased CO2 level (Hanif et al. 2019) nitrogen fertilisation increases N2O (Halvorson et al. 2010), cattle and rice production increases methane in atmosphere (Reay et al. 2010). Agroforestry is afforestation activity with crop cultivation and has promising potential to sequester atmospheric carbon into soil (Abbas et al. 2017). Organic approach in agriculture has relatively low potential to emit N2O (Peterson et al. 2011). Through photosynthesis plants play a vital role in global climate change (Alfaro et al. 2014).

Microorganisms found in soil play an important role to enhance the soil fertility; microbes process many biogeochemical cycling and facilitate soil mineral nutrient availability such as nitrogen phosphorus and sulphur (Basu et al. 2021). Soil microbes are a key indicator of soil fertility and the organism is positively affected by the applying organic manure (Hao et al 2008). Metagenomics is a study of uncultured organisms to understand the true diversity of microbes, their functions, cooperation, and evolution (Huson et al. 2009). It does not require PCR amplification or cloning (Mukherjee et al. 2019).

IMPORTANCE OF STUDY

The present study has been designed to study the overall dynamics of ecological parameters of biodiversity park (Anupam Upavan) developed by Dayalbagh Educational Institute. The study includes dynamics of physicochemical properties of soil, water and microclimate and their role in improving the quality of life of human beings and the health of the ecosystem. Several reports suggest adverse effects of anthropological activities such as urbanisation, industrialization, conventional agriculture practice and insensitivity of human beings towards nature severely damaging the ecosystem, biodiversity and a major cause of climate change, so this study finds the capability of agroforest to improve the ecological factors and mitigation of the environmental challenge through these agroecosystems. Additionally, increased biomass productivity, genetic diversity, carbon sequestration, improving soil and air quality,

using waste water while keeping harmony with nature is a challenge but it seems possible through agro ecological parks and this study will give scientific insights.

PROPOSED METHODOLOGY

- **Soil Testing:**

  Initially, Soil Texture, Bulk density, Moisture, pH, Conductivity, (FAO: Soil testing methods manual 2020), Macronutrients such as Nitrogen (Amule, F. C. 2014) Potassium (Vumitti, D 2015), Phosphorus (Sreenivasulu et al. 2017), some micronutrients, heavy metals (Ozkan et al. 2019) by using MP-AES and Organic carbon (FAO 2019) will be analyzed.

- **Water testing:**

  The basic physical parameters including turbidity, solids, temperature, electrical conductivity and chemical parameters such as acidity and biological oxygen demand will be analysed by the Systronic 371 water analyzer. The selected heavy metal concentration of water will be analysed by using MP-AES (Kamla et al. 2014).

- **Air quality estimation:**

  Atmospheric particulate matter will be analysed by IAQ 3007R (Ren et al. 2018; Zheng et al. 2017).

- **Floral diversity and richness:**

  The number of the plant species and their richness will be studied to find out dynamics of the ecosystem complexity (Mane et al. 2019).

- **Metagenomics:**

  Metagenomics of the soil of different parks will be done (Arjun J.K. 2011; Enebe et al. 2020; Huson et al. 2009).

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